REMARKS

Claims 9-11 and 17 has been canceled, and claims 21-29 have been added. No new matter was added. Thus, claims 1, 2, 4, 5, 12-16, 18, 19 and 21-29 are pending. The claims have been amended to overcome formalities and/or to distinguish over the prior art of record. Accordingly, Applicants respectfully submit that the present application is in condition for allowance.

I. Claim Objections

In the non-final Office Action dated December 22, 2008, numerous objections are made with respect to claims 1, 2, 4, 5 and 17-20.

Claims 1, 4, 18 and 19 are objected to because of the use of "at%". The abbreviation "at%" refers to "atomic percent". One of ordinary skill in the art is aware of the meaning of atomic percent (i.e. the number of atoms of an element per unit volume divided by the number of atoms per unit volume of the substance containing the element). The claims have been amended to refer to "atomic percent". No new matter was added. For example, see reference to "at %" in the top of Table 1 on page 10 of the present application, as filed. Applicants respectfully request reconsideration and removal of the objection.

Claims 1 and 4 are objected to because of the phrase "unavoidable impurities". This phrase has been deleted from all claims. Applicants respectfully request reconsideration and removal of the objection.

Claims 1, 2, 4, 5, 18 and 19 are objected to because of an improper Markush grouping form. The Markush groupings have been corrected in a form as suggested by the Examiner. Applicants respectfully request reconsideration and removal of the objection.

Claims 1, 2 and 18-20 are objected to because of the combination of closed-ended and open-ended terminology. The transitional term after the preamble of claim 1 has been amended to "comprising" and the requirement of "at least one element" is submitted as being proper. The transitional term after the preamble of claim 19 is "consisting of" and the requirement of "at least one element" has been amended to "an additional element", which is also submitted as being proper. Applicants respectfully request reconsideration and removal of the objection.

Claim 19 is objected to because the "purity" percentage is "unclear". The limitation concerning the purity has been deleted. Applicants respectfully request reconsideration and removal of the objection.

Further, claims 1 and 19 were amended to require "a sputtering target body of a predetermined diameter and a predetermined thickness adapted to form a thin film via magnetron sputtering". No new matter was added. For example, see page 8, lines 1-5, and page 11, lines 1-3, of the present application, as filed. New dependent claims 21-29 were also added. No new matter was added. For example, see page 10, Table 1, for examples of the "added element" and page 8, lines 1-5, for an example of the diameter and thickness of the sputtering target.

II. Claim Rejections – 35 USC §103(a)

> *In the non-final Office Action dated December 22, 2008, claims 1, 2, 4, 5 and 9-20 are rejected under 35 USC §103(a) as being obvious over U.S. Patent Application Publication No. 2003/0193094 A1 of Takahashi et al. in view of JP 56-110230 of Ichikawa et al. and further in view of JP 2000-169957 of Obara et al.*

Turning first to the secondary references, Ichikawa et al. is cited in the Office Action solely for its disclosure of a percentage of copper (24-39 percent by weight) in an alloy and Obara et al. is cited solely for its disclosure of vanadium in an alloy within a range of 5-20

percent by weight. The primary reference, Takahashi et al., is relied upon as disclosing all other claim limitations.

Applicants respectfully submit that Takahashi et al. clearly fail to teach, suggest or disclose the invention required by the claims, as amended, of the present application and that Ichikawa et al. and Obara et al. fail to cure the deficiencies of the Takahashi et al. reference. More specifically, Applicants respectfully submit that one of ordinary skill in the art would not arrive at the present invention based only on the unrelated teachings of these references.

The claims, as amended, of the present application include claims 1, 2, 18, 19 and 21-27 directed to a sputtering target and claims 4, 5, 12-16, 28 and 29 directed to an assembly including a thin film between a solder bump and a substrate layer or pad. These claims are discussed separately below with respect to the above rejection.

Sputtering Target Claims

Claims 1, 2, 18, 19 and 21-27 of the present application are directed to the structure of a sputtering target. Each of these claims, as amended, requires the sputtering target to comprise or consist of a sputtering target body of a predetermined diameter and a predetermined thickness adapted to form a thin film via magnetron sputtering. The composition of the sputtering target body is required to be 1 to 30 atomic percent of copper (Cu); 2 to 25 atomic percent of vanadium (V), chromium (Cr), aluminum (Al), silicon (Si), or molybdenum (Mo); and remnant nickel (Ni). Claim 18 further requires the composition to include titanium (Ti); claim 19 further requires the sputtering target body to having a single phase metallographic structure and an average grain size of 100μm or less; claims 21 and 24 require the additive element to be limited to Cr, Al, Si or Mo;

claims 22 and 25 require the additive element to be limited to Al, Si or Mo; and claims 23, 26 and 27 require the sputtering target body to have a thickness of 10mm or a diameter of 80mm.

Sputtering is a process whereby atoms are ejected from a solid material (referred to as a sputtering target) due to bombardment of the target by energetic ions. In magnetron sputtering, the sputtering is enhanced via the use of intense magnetic fields. Sputtering is used for thin-film deposition. Thus, the term "sputtering target body", as used in the claims, as amended, of the present application, has a definition that is well known to one of ordinary skill in the art. One of ordinary skill in the art certainly understands the difference between the structure of a sputtering target body and that of a thin film. A typical sputtering target body has a disc-shape of a predetermined diameter and thickness measured, for instance, in tens of mm; whereas, a thin film is typically measured in microns or angstroms. The above referenced claims of the present application are clearly limited to a sputtering target body, and do not read on a thin film.

The primary reference in the above cited rejection is the Takahashi et al. publication. In the Office Action, it is stated that: "Takahashi discloses a nickel alloy **sputtering target** film 7 ... to inhibit the **diffusion of Sn** between a solder bump 6 and a substrate 9 (see figure 2B; Paragraph [0058])." Applicants respectfully submit that this interpretation of Takahashi et al. is inaccurate for the following reasons.

Paragraph No. 0058 of Takahashi et al. states, as follows:

> "In the heat treatment step, as shown in FIG. 2B, Sn and Cu in the Cu-added solder ball bumps 6 rapidly react with Ni in the Ni bond layers 3 to form diffusion inhibitive alloy layers 7. This diffusion inhibitive alloy layer is an intermetallic compound formed of Ni—Cu—Sn. Different from the prior art, the diffusion inhibitive alloy layers 7 formed of Ni—Cu—Sn have a function of inhibit ***heat diffusion of Ni atoms*** as described later."

Most importantly, it should be understood that a correct interpretation of Takahashi et al. is that the film 7 disclosed by Takahashi et al. is configured from a Ni-Cu-Sn intermetallic

compound that is for the purpose of inhibiting thermal diffusion of Ni atoms. It is entirely incorrect to interpret film 7 of Takahashi et al. as a **sputtering target body** adapted to form thin films via magnetron sputtering and as being made of Cu, Ni **and an additive element** (selected from V, Cr, Al, Si or Mo) for use in forming a thin film for **inhibiting Sn diffusion**.

In addition, as best stated in Paragraph No. 0055 of Takahashi et al., "the present invention is characterized in that a **micro amount of Cu atoms** are added to the solder ball bump." In other words, Takahashi et al. teaches to one of ordinary skill in the art to add trace amounts of Cu atoms to the solder ball bump in order to form the desired diffusion inhibitive layer 7 of Ni—Cu—Sn. The trace amount is further defined in Paragraph Nos. 0065-0066 of Takahashi et al. which state that only 0.2wt% to 0.3wt% Cu should be added to the solder ball bump. Paragraph No. 0065 provides a teaching to one of ordinary skill in the art why no more than 0.3wt% Cu can be added (i.e. Takahashi et al. teach-away from adding more than 0.3wt% of Cu).

Still further, the film 7 of Takahashi is clearly a thin film, not a sputtering target body. The film 7 is not adapted for use as a sputtering target to form a thin film via magnetron sputtering. The film 7 is only formed after the heat treatment of a copper-added solder bump (reference numeral 6 in FIG. 2A of Takahashi et al.) on a Ni-bond layer (reference numeral 3 in FIG. 2A of Takahashi et al.). After the heat treatment, the film 7 is formed as an intermetallic compound of Ni (from the Ni bond layer 3) and Cu and Sn (from the copper-added solder bump 6). The diffusion inhibitive alloy layer 7 is **only 2μm thick** and contains only **0.1 wt % total of Cu and Sn**. See Paragraph No. 0069 of the Takahashi et al. publication. Accordingly, layer 7 of Takahashi et al. is **not** a sputtering target body, **cannot** be used to form thin films via magnetron sputtering, does **not** contain at least one of V, Cr, Al, Si and Mo, does **not** contain 2 to 25 atomic

percent of at least one of V, Cr, Al, Si and Mo, and does **not** contain 1 to 30 atomic percent of Cu.

Finally, the ultimate objective of film 7 taught by Takahashi et al. is to prevent the formation of a P concentrate layer. For example, Paragraph No. 0016 of Takahashi et al. discloses a prior art structure (in FIGs. 1A-1C) in which a P concentrate layer 108 is formed. Paragraph No. 0017 describes the problem with the P concentrate layer 108, as follows:

> "... The heat diffusion of the Ni atoms increases without any limitation. Subsequently, the above-described P concentrate layers 108 or regions have a low density of Ni atoms. In the vicinity of the P concentrate layer 108 or the coarse region, the solder ball bumps 106 are frequently peeled/broken. This is because these regions have brittle physical properties."

Thus, following the teachings of Takahashi et al. as disclosed in Paragraph No. 0059, the formation of the P concentrate layers in the prior art can be "largely reduced".

Accordingly, Applicants respectfully submit that Takahashi et al. fail to address the problem addressed by the present invention and fail to provide a solution. Further, the deficiencies with respect to Takahashi et al. is that Takahashi et al. fail to disclose a sputtering target body, cannot be used to form thin films via magnetron sputtering, does not contain at least one of V, Cr, Al, Si and Mo, does not contain 2 to 25 atomic percent of at least one of V, Cr, Al, Si and Mo, and does not contain 1 to 30 atomic percent of Cu. Rather, Takahashi discloses a film 7 that is only 2μm thick formed by the heat treatment of a Cu-added solder bump on a Ni thin film (not by sputtering). The thin film 7 includes only trace amounts of Cu, and Takahashi et al. teaches that only a trace amount can be used and that increased amounts of Cu should be avoided (see Paragraph No. 0065).

The secondary reference, Ichikawa et al., discloses a Ni-Cu alloy that is for use as an electrode and that has a relatively large amount of Cu (i.e. 24-39wt%).

Applicants respectfully submit that it would not be obvious for one of ordinary skill in the art to modify the film 7 disclosed by Takahashi et al. by increasing the percentage of Cu in the Ni—Cu—Sn intermetallic compound diffusion inhibitive layer 7 of Takahashi et al. to contain 24 to 39 percent by weight of Cu. This is because Takahashi et al. clearly provides a teaching that no more than 0.3wt% of Cu can be added into the Cu-added solder bump (see Paragraph No. 0065) and that as a result, after heat treatment, the Ni—Cu—Sn intermetallic compound diffusion inhibitive layer 7 contains only about 0.1wt% in total of Cu and Sn (see Paragraph No. 0069).

"Teaching away" is the antithesis of the art suggesting that the person of ordinary skill in the art go in the claimed direction. Essentially, "teaching away" is a per se demonstration of lack of obviousness. In re Fine, 873 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

In addition, when a §103 rejection is based upon a modification of a reference that destroys the intent, purpose or function of the invention disclosed in the reference, such a proposed modification is not proper and a *prima facie* case of obviousness cannot be properly made. In re Gordon, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984).

Accordingly, based on the requirement that only a trace amount (no more than 0.3wt%) of Cu can be added to the solder bump of Takahashi et al. and that, therefore, only a trace amount (no more than 0.1wt% in total of Cu plus Sn) is contained in the layer 7 of Takahashi et al., Applicants respectfully submit that Takahashi et al. teach-away from the requirement of 1 to 30 atomic percent of Cu required by the claims of the present invention and teach-away from using 24 to 39wt% taught by the electrode alloy of the Ichikawa et al. reference. Further, modifying film 7 of Takahashi et al. such that it contains 24 to 39 wt% of Cu would destroy the intent, purpose and function of film 7 as disclosed by the Takahashi et al. reference. The solder

bump taught by Takahashi et al. must contain no more than 0.3wt% Cu, and the film 7 of Takahashi et al. cannot contain more than 0.1wt% of Cu plus Sn. See Paragraph Nos. 0065, 0066 and 0069 of the Takahashi et al. reference.

The Obara et al. published Japanese application merely discloses a Ni-V alloy. Obara et al. fail to overcome any of the above referenced deficiencies with respect to Takahashi et al and the Ichikawa et al. reference.

Accordingly, Applicants respect submit that independent claim 1 of the present application is patentable over Takahashi et al. in view of Ichikawa et al. and further in view of Obara et al. for the above stated reasons.

Applicants also submit that the other claims of the present application directed to a sputtering target contain additional reasons for patentability over the cited references. Claim 18 requires the further addition of Ti. Claim 19 requires the composition to consist of the claimed elements and requires a single phase metallographic structure (not an intermetallic compound) and a crystal grain size of 100μm. Claims 21 and 24 require the additive element to be Cr, Al, Si or Mo (not V taught by Obara et al.). Claims 22 and 25 require the additive element to be Al, Si or Mo. Claims 23 and 26 require a sputtering target body thickness of 10mm (not 2μm as taught by film 7 of Takahashi et al.), and claim 27 requires a diameter of 80mm. The intermetallic compound formed according to the teachings of Takahashi et al. cannot be produced to such sizes as required by a sputtering target.

Accordingly, Applicants respectfully request reconsideration and removal of the rejection of claims 1, 2, 18, 19 and 21-27.

Thin Film Claims

Claims 4, 5, 12-16, 28 and 29 of the present application are directed to an assembly including a thin film between a solder bump and a substrate layer or pad. The Cu in the thin film of the present invention reacts with the Sn-containing solder to form a Cu-Sn intermetallic compound which yields the effect of inhibiting the diffusion of Sn. (See claims 9-16 and page 5, line 27, to page 6, line 5, of the present application.) The Cu in the thin film is required to be 1 to 30 atomic percent.

As described in detail above, Takahashi et al. disclose a thin film 7 made of a intermetallic compound of Ni—Cu—Sn which contains only a trace amount of about 0.1wt% in total of Cu plus Sn and a large amount (99.9wt%) of Ni. For reasons already stated, Takahashi et al. teach-away from the film containing more than 0.1wt% of Cu because the Cu-added solder bump from which the Cu diffuses can contain no more than 0.3wt% of Cu. Thus, Takahashi et al. teach away from the Cu content required by claim 4 of the present application. In addition, one of skill in the art would not simply increase the Cu added to the solder bump of Takahashi according to the content of 24 to 39wt% of Cu in the alloy taught by Ichikawa et al., because such addition would destroy the intent, purpose and function of the invention (film 7) disclosed in the Takahashi et al. reference.

Accordingly, Applicants respectfully submit that claim 4 of the present application is patentable over the cited combination of references.

Applicants further submit that dependent claims 13 and 15, as amended, provide additional reasons for patentability. Claims 13 and 15 require the thin film to be an intermediate compound layer and require this layer to "consist" of Cu and Sn. No new matter was added. For example, see page 5, line 27, to page 6, line 2, of the present application, as filed. Thus, unlike

Takahashi et al. which requires a film 7 that contains a large amount of Ni and only trace amounts of Cu and Sn, the present invention provides an intermetallic compound layer having only Cu and Sn without Ni. This limitation is not disclosed, taught or suggested by the cited references.

Finally, claim 28 requires the additive element to be Cr, Al, Si or Mo, and claim 29 requires the additive element to be Al, Si or Mo. These limitations are not disclosed, taught or suggested by the cited references.

For these reasons, Applicants respectfully request reconsideration and removal of the rejection of claims 4, 5, 12-16, 28 and 29.

III. Conclusion

In view of the above amendments and remarks, Applicants respectfully submit that the rejections have been overcome and that the present application is in condition for allowance. Thus, a favorable action on the merits is therefore requested.

Please charge any deficiency or credit any overpayment for entering this Amendment to our deposit account no. 08-3040.

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